UNIVERSITY OF CALIFORNIA, BERKELEY

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March 25, 1996

Scientific Officer Code: 311SP
Julia Abrahams
Office of Naval Research
Ballston Tower One
800 North Quincy Street
Arlington, VA 22217-5660

Re: N00014-94-1-0042
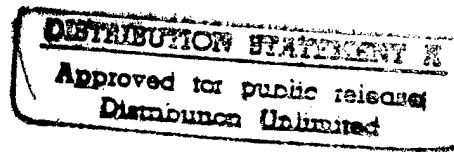
Dear Sir,

Enclosed is the final report for the ONR grant "Moving particle tracks: modelling and data analysis" under the direction of David R. Brillinger, Department of Statistics, University of California, Berkeley.

If you have any questions regarding this report, Professor Brillinger may be reached by email at brill@stat.berkeley.edu, or telephone (510)642-0611. I am the department's contracts and grants assistant, I can be reached by email at jane@stat.berkeley.edu, or telephone (510)642-9593.

Sincerely yours,

Jane Muirhead
Administrative Assistant

cc: ONR Administrative Grants Officer
      ONR, Director, Naval Reserach Laboratory
      ONR, Defense Technical Information Center
      Sponsored Projects Office, Pat Gates,

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
SEATTLE REGIONAL OFFICE
1107 NE 45TH STREET, SUITE 350
SEATTLE WA 98105-4631

IN REPLY REFER TO:

4330
ONR 247
11 Jul 97

From: Director, Office of Naval Research, Seattle Regional Office, 1107 NE 45th St., Suite 350, Seattle, WA 98105

To: Defense Technical Center, Attn: P. Mawby, 8725 John J. Kingman Rd., Suite 0944, Ft. Belvoir, VA 22060-6218

Subj: RETURNED GRANTEE/CONTRACTOR TECHNICAL REPORTS

1. This confirms our conversations of 27 Feb 97 and 11 Jul 97. Enclosed are a number of technical reports which were returned to our agency for lack of clear distribution availability statement. This confirms that all reports are unclassified and are "APPROVED FOR PUBLIC RELEASE" with no restrictions.

2. Please contact me if you require additional information. My e-mail is *silverr@onr.navy.mil* and my phone is (206) 625-3196.
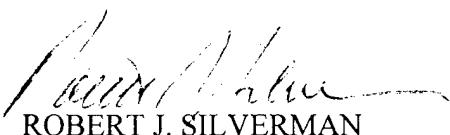
ROBERT J. SILVERMAN

Final Report on ONR Grant N00014-94-1-0042 (D.R. Brillinger)

This grant was awarded for the Performance/Budget Period 10/01/93 - 9/30/96. In July 1994 I was informed that the ONR Mathematics, Computer and Information Sciences Program was being reevaluated in terms of ONR priorities and available resources and that the grant was to end in FY95, not FY96. An extension on spending the remaining funds was given to 12/31/95. Some of the goals of the original grant have not yet been accomplished in consequence of the reduction.

However, substantial progress has been made on the topic of the award, which was "*Moving particle tracks: modelling and data analysis*" and intense research on the topic does continue. In particular, see the invited talks listed below, where a broad range of results will be presented. It should be noted that some of the research is collaborative with Brent S. Stewart of Hubbs Sea World.

The material to be presented in the invited talks, and based on the research so far accomplished, focuses on the problems of: i) fitting joined line segments to time-depth data $(t,z(t))$ and the associated problems of identifiability, ii) the study of surface tracks $(x(t),y(t))$ and iii) the study of 3D trajectories $(x(t),y(t),z(t))$. In each case t refers to time. The work involves building stochastic models, fitting them to data and assessing the fit. In the circumstance of simultaneous movement of several animals, the models include terms for (possible) interactive behavior. The advantage of the formulation being developed is that a wide variety of scientific questions of interest (eg. interactions present?, similar tracks followed? ...) may be formulated in terms of parameters. Another advantage is that it becomes clear which basic computer programs to develop to handle the many large data sets available.

The paper I (listed below) begins a tieing together of graphical models (graphs with random variates associated with each node) and networks of random processes. One goal is inferring an associated wiring diagram. The paper J (listed below) presents an analysis of time series, whose values are ordinal (ordered categories), able to be implimented in standardized generalized linear model packages. One concern addressed is assessing the goodness of fit of models for such situations. These devlopments, in part, grew out of the problem of describing trajectories.

Further papers, with support from the Grant:

Papers that had appeared and were to appear were listed in the Progress Report of June 30, 1995. Two papers mentioned there as "in preparation" are now completed. These are I and J below. Updated citations are provided below for those citations that changed. The lettering continues that of the 1995 Progress Report.

F. Trend analysis: binary-valued and point process cases, *Stoch. Hydrology and Hydraulics (1995) 9, 207-213*.

G. On a weather modification problem of Professor Neyman, *Prob. and Math. Statistics (1995) 15, 115-125*.

I. Remarks concerning graphical models for time series and point processes, *Revista de Econometria*, to appear (1996).

J. An analysis of an ordinal-valued time series, Volume Dedicated to E.J. Hannan, to appear (1996). J. An analysis of an ordinal-valued time series, *Volume Dedicated to E.J. Hannan*, to appear (1996).

Talks and Presentations.

A poster, "Computer-assisted, automatic evaluation of two-dimensional profiles (time vs. depth) of time-series data for diving marine mammals" D.R. Brillinger, B.S. Stewart and A. Wang, was presented at the December 1995 Marine Mammal Conference, Orlando Florida.

An invited talk "Statistical analysis of the tracks of moving particles" will be presented at the meeting of the Statistical Society of Brazil Meeting, Caxambu, July 1996.

An invited talk "Spatio-temporal modelling and analysis of particle trajectories, eg. marine mammals" will be presented at the Modelling Longitudinal and Spatially Correlated Data Meeting, Nantucket, October 1996.

David R. Brillinger

March 13, 1996